1.0 Admin micropackets

Admin micropackets are used for support and initialization of HIPPI-6400 links, elements, and systems.

1.1 Element definition

An element is any individually addressable part of a HIPPI-6400 system that is able to receive and send micropackets conforming to this standard. At a minimum, each end of a HIPPI-6400 link shall operate as an element capable of participation in element function discovery and Source ULA negotiation.

Other components of switches or adapters may optionally conform to the element definition provided herein. These could include adapter cards, integrated circuits, or software entities.

1.2 Element conformance

At a minimum, HIPPI-6400 elements shall support commands and responses for the discovery of element function and logical address assignment. Implementation of other functions called for by admin micropacket commands are optional. If an element does not implement an admin command, it shall return status to that effect in the response micropacket. All elements shall respond to each admin micropacket command with the specified response admin micropacket.

1.3 Admin micropacket functions

A small set of commands allow for:

- Diagnostic “pings” between HIPPI-6400 elements, either locally or across a link
- Initial element address assignment
- Discovery of the function of an element (e.g. switch or non-switch)
- HIPPI-6400 logical address (Source ULA) assignment
- Vendor specific register access

1.4 Admin micropacket format

Table 1 and Figure 1 both show the format of an admin micropacket. Admin micropackets contain:

Table 1. Admin Micropacket Format

Byte	Function
0	Key
1	Hop Count
2:3	Destination Admin Register (logical address of register within an element)
4:7	Destination Admin Element Address (logical address of element in HIPPI-6400 domain)
8	Admin Command (see Table 2)
9	Status flags (see Table 3) / Return Hop Count
10:12	Source Admin Register (logical address of register within an element)
12:15	Source Admin Element Address (logical address of element in HIPPI-6400 domain)
16:31	Data Register

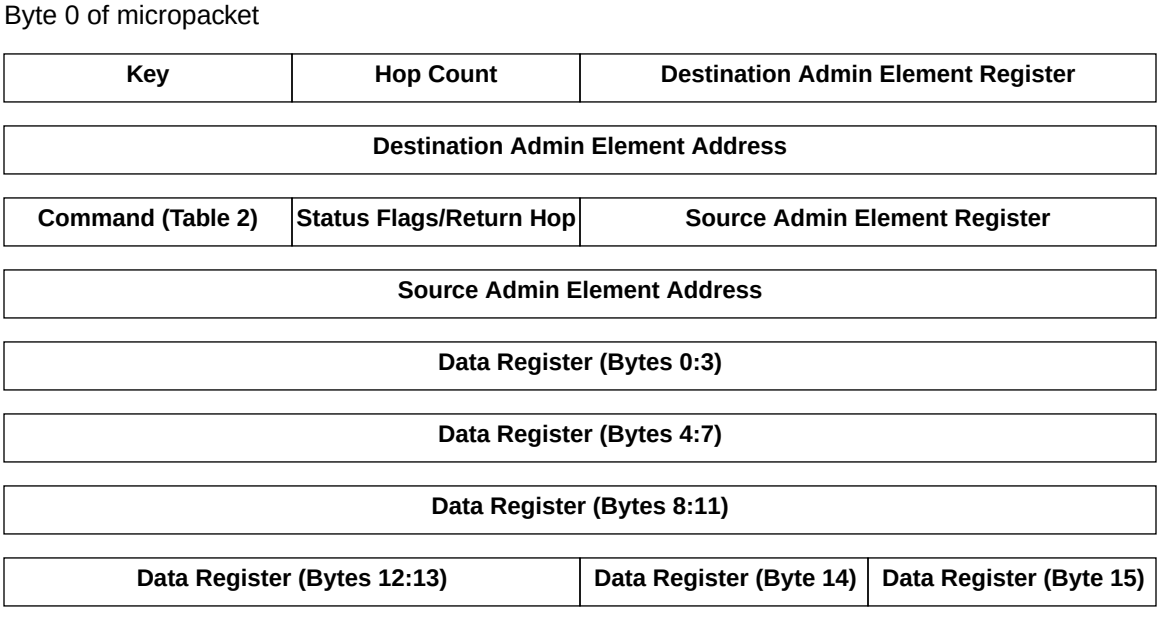

Figure 1. Admin Micropacket Byte Format

- Key: The Key field is used in certain operations to validate that the originator is authorized to perform the requested operation. Because the key is only 8 bits in length and is returned in response to the SET ELEMENT ADDRESS, the protection provided by the key is minimal and only protective against accidental changes.
  Implementors may also choose to protect their system configuration in other unspecified ways. For example, a vendor may only allow commands that cause configuration changes to occur through a specific port.
- Hop Count: The value contained in the Hop Count field shall be decremented once each time the admin micropacket is moved through an element. If the hop count reaches zero, the micropacket shall be discarded without a response if it cannot be processed in the current element.
  If the destination admin element address is 0xFFFFFFFF, a hop count of zero shall indicate that the admin micropacket is valid for local processing. All other hop count values in conjunction with a destination admin element address of 0xFFFFFFFF indicate that the micropacket shall continue to be forwarded.
  If a micropacket is forwarded to the end of a link without a valid address match, it shall be discarded without a response.
- Destination Admin Register: The Destination Admin Register field specifies a register address within a HIPPI-6400 element. There are no specific registers required in any element by this standard and use of any register addresses is optional.
- Destination Admin Element Address: The Destination Admin Element Address field shall be used to specify a particular element of a HIPPI-6400 system that is the destination of an admin micropacket command.
- Admin Command: The Admin Command field shall contain a value to specify the meaning and interpretation of the admin micropacket. Table 2 contains all of the defined values, along with a description of the functions and parameters associated with each command.
- Status Flags / Return Hop Count: When the admin micropacket is a command, the Return Hop Count field shall be used to communicate the proper hop count value for returning status. The Return Hop Count field may be set to 0xFF when using element addressing in lieu of a specific return distance. When the admin micropacket is a response, the Status Flags field shall be used to return operation results. Table 3 provides definitions for each bit. In each case, flag bit = 1 indicates that the listed exception has occurred.

Table 3. Status Flags

Bit	Meaning
0	Undefined Operation
1	Invalid Key
2	Parameter out of range
4	Invalid Address
5	Data Register Not valid
6	Unimplemented Command
7	Operation Failed

- Source Admin Register: The Source Admin Register field may be used to specify a register address within a HIPPI-6400 element that can be used as a “reply-to” address for certain operations. There are no specific registers required in any element by this standard.
- Source Admin Element Address: The Source Admin Element Address field is used to specify the particular element of a HIPPI-6400 system that initiated a sequence of admin packets. The source admin element address shall be used as a “reply-to” address.

Table 2. Admin Commands

Command Value	Function	Virtual Channel	Key Required?	Action
0x0	PING	1	No	The receiving element shall return a PING RESPONSE. The Data Register field may be used to send data that will be echoed in the PING RESPONSE.
0x1	PING RESPONSE	2	No	Acknowledges the PING command. The receiving element uses this response to validate that the PING'ed element is operational. The Data Register field shall contain a copy of the data originally sent in the PING command.
0x2	SET ELEMENT ADDRESS	1	Yes, except first time after reset	The use of admin micropacket commands for element address assignment is optional. No element is required to assign element addresses. If this is the first SET ELEMENT ADDRESS command received after a reset, the value in the Key field is ignored. Later uses of the SET ELEMENT ADDRESS command require that the Key field value match the current key. If the above criteria for key value are met, the receiving element sets it's base admin address to be equal to the value set in the lower 4 bytes (12:15) of the Data Register field, sets it's key value to the new key provided in byte 8 of the Data Register and acknowledges with a ACK SET ELEMENT ADDRESS response. The provided key shall be retained for subsequent command validity checking. Once the base address is set, it cannot be changed without providing the key value unless the element is reset.

Table 2. Admin Commands

Command Value	Function	Virtual Channel	Key Required?	Action
0x3	ACK SET ELEMENT ADDRESS	2	yes	The use of admin micropacket commands for element address assignment is optional. An element incapable of setting its address shall set the Unimplemented Command flag in the flag byte. This response acknowledges the SET ELEMENT ADDRESS command. The current valid key is returned in byte 8 of the Data Register field. The current address of this element is returned in the lower 4 bytes (12:15) of the Data Register field. The current element address and proper key value are returned regardless of the success or failure of the SET ELEMENT ADDRESS operation.
0x4	RESET	1	yes	Reset shall cause an element to initialize itself. This includes clearing the current element address and key. Reset may be propagated further depending upon vendor specific implementation and configuration. There is no message response to a RESET command.
0x5	EXCHANGE ELEMENT FUNCTION	1	no	The sender provides its Element Function value in the least significant byte (0) of the Data Register and requests the receiver to respond with a ELEMENT FUNCTION RESPONSE. Element Function may be: • switch element (00) Used for a switch that can assign logical addresses to endpoints. • Link-end element (01) Used when the element is a link-end that does not directly assign or use logical addresses • Non-switch element (02) Used for an end-point that requires a logical address assignment. • Unknown element (03) Used when the element does not deal with logical addresses in any manner, but is an endpoint. Other bytes in the Data Register are defined as Vendor Unique and may be used in any way desired by the equipment provider.

Table 2. Admin Commands

Command Value	Function	Virtual Channel	Key Required?	Action
0x6	ELEMENT FUNCTION RESPONSE	2	no	In response to a EXCHANGE ELEMENT FUNCTION command, the sender provides its Element Function value in the least significant byte (0) of the Data Register. Element Function may be: • switch element (00) Used for a switch that can assign logical addresses to endpoints. • Link-end element (01) Used when the element is a link-end that does not directly assign or use logical addresses • Non-switch element (02) Used for an end-point that requires a logical address assignment. • Unknown element (03) Used when the element does not deal with logical addresses in any manner, but is an endpoint. Other bytes in the Data Register are defined as Vendor Unique and may be used in any way desired by the equipment provider.
0x7	RETURN LOGICAL ADDRESS	1	no	The sender requests that the receiver return a HIPPI-6400 logical address for the sender to use (as a Source ULA) via a LOGICAL ADDRESS RESPONSE. The sender provides his offered base ULA in bytes (10:15) of the Data Register. The most significant bit of byte 6 of the Data Register indicates that this is an additional request for an address and that previous addresses assigned to this port should be retained as valid in addition to the address(es) assigned by this use of the command. The balance of bytes (6:7) contains a count of desired addresses. As specified in HIPPI-6400-SC, this command is normally issued by endpoints.

Table 2. Admin Commands

Command Value	Function	Virtual Channel	Key Required?	Action
0x8	LOGICAL ADDRESS RESPONSE	2	no	The Data Register provides the value to be used by the receiver as its HIPPI-6400 logical address (Source ULA) in response to a Return Logical Address command. Bytes (10:15) of the Data Register contain the ULA for the receiver to use. This may or may not be the offered Source ULA passed in the Return Logical Address command. For a receiver needing to add a single address, this value shall be directly utilized. If the most significant bit of byte 6 is set, it indicates that the address(es) assigned are in addition to those assigned in a previous LOGICAL ADDRESS REQUEST/RESPONSE operation. For a receiver needing multiple addresses, the balance of bytes (6:7) provide a count of sequential addresses assigned that start at the base value contained in bytes (10:15) of the Data Register. As specified in HIPPI-6400-SC, this response is normally issued by switches.
0x9	READ REGISTER	1	Optional (use of a key may or may not be required for any or all register access)	The use of admin micropackets for register access is optional. If register access commands are supported, there are no requirements for particular addressing functions or modes specified by this standard. The sender requests a register value from the specified address. The receiver acknowledges the request with a READ RESPONSE. Contents of registers and their meaning are not addressed in this standard.

Table 2. Admin Commands

Command Value	Function	Virtual Channel	Key Required?	Action
0xA	READ RESPONSE	2	No	The use of admin micropackets for register access is optional. If register access commands are supported, there are no requirements for particular addressing functions or modes specified by this standard. An element incapable of supporting this operation shall set the Unimplemented Command flag in the flag byte. The sender returns the data from the addressed register contents in the Data Register. • Single bytes sent in byte (15) • Two byte words sent in bytes (14:15) • Four byte words sent in bytes (12:15) • Eight byte words sent in bytes (8:15) • Sixteen byte words sent in bytes (0:15) Contents of registers and their meaning are not addressed in this standard.
0xB	WRITE REGISTER	1	Optional (use of a key may or may not be required for any or all register access)	The use of admin micropackets for register access is optional. If register access commands are supported, there are no requirements for particular addressing functions or modes specified by this standard. No element is required to issue this command. The sender requests that a register value be updated with the value contained in the Data Register. The receiver acknowledges the request with a WRITE RESPONSE. • Single bytes sent in byte (15) • Two byte words sent in bytes (14:15) • Four byte words sent in bytes (12:15) • Eight byte words sent in bytes (8:15) • Sixteen byte words sent in bytes (0:15) Contents of registers and their meaning are not addressed in this standard.

Table 2. Admin Commands

Command Value	Function	Virtual Channel	Key Required?	Action
0xC	WRITE RESPONSE	2	no	The use of admin micropackets for register access is optional. If register access commands are supported, there are no requirements for particular addressing functions or modes specified by this standard. An element incapable of supporting this operation shall set the Unimplemented Command flag in the flag byte. The sender echoes the value written to the specified address in the Data Register. The contents of the Data Register shall be sent as zeros if the update was not successful. Contents of registers and their meaning are not addressed in this standard.
0xD	ERROR RESPONSE	2	no	ERROR RESPONSE shall be sent when an undefined command is received on VC1. No response is ever made to undefined admin micropackets received on VC0, VC2, or VC3.
0xE - 0xFF	undefined	N/A	N/A	Not defined. Shall not be sent.

- Data Register: The Data Register is a 16 byte field that shall be used to carry data for any admin operation

1.5 Addressing of admin micropackets

The admin micropacket format contains a 32 bit source and destination admin element address. This space is adequate to uniquely identify elements in configurations of up to 2^{32} elements.

With two port devices, a received admin micropacket is destined for local processing by the element, or is discarded, or is forwarded out the second port.

Response admin micropackets shall be sent on the port that received the original admin micropacket command. Response admin micropackets shall use the source admin element address and return hop count provided in the original admin micropacket command as the destination admin element address and hop count.

There are two possible destination admin element addresses that can result in delivery of an admin micropacket to an element for local processing:

- If the assigned element address matches the destination admin element address.
  This technique allows use of a flat logical address space for access to each element when all of the element addresses are known.
- If the destination admin element address = 0xFFFFFFFF and hop count = 0
  This technique allows access to neighbors (who may possibly have unknown addresses) by setting the hop count to control how far distant an element is in hop count. For example, a hop count of three would pass through three neighboring elements before being decremented to zero and being processed by the third element.

If a received admin micropacket contains one of the two possible valid addresses pointing to the current local element, it shall be processed locally. Otherwise, if the hop count value is zero, the packet shall be discarded. Then the hop count shall be decremented by one and the packet shall be forwarded to the element's other port, i.e., the port that did not deliver this micropacket to this element.

Admin micropackets shall be sent on the VC specified for each command and response:

- No admin micropackets shall be sent on VC0.
- All command admin micropackets shall be sent on VC1.
- All response admin micropackets shall be sent on VC2.
- No admin micropackets shall be sent on VC3.

Receivers of admin micropackets shall only process and/or respond to admin micropackets received on the specified proper VC:

- Admin micropackets received on VC0 shall be logged as an error and discarded without a response.
- Admin micropackets received on VC1 shall be processed as a received command, discarded (due to an expired hop count), or forwarded (if the address does not match).
- Admin micropackets received on VC2 shall be processed as a received response, discarded (due to an expired hop count), or forwarded (if the address does not match). Responses that are received unexpectedly shall be logged as an error and discarded without a response. A response admin micropacket shall never be sent in reply to an admin micropacket received on VC2.
- Admin micropackets on VC3 shall be shall be logged as an error and discarded without a response.

Admin micropackets that arrive with either ERROR = 1 or TAIL = 0 shall be logged as an error and discarded without a response.

Selection of the proper port for packet forwarding, from a set of ports in a multi-port element, is not covered by this standard. Multi-port element support is optional and may be added in a vendor unique manner.

1.6 Admin element address assignment

Each element in a HIPPI-6400 connected collection of elements may be provided an element address for operation and control. Element addresses may be assigned through any suitable means, including use of the commands, SET ELEMENT ADDRESS and ACK SET ELEMENT ADDRESS. These commands allow an intelligent system element to assign element addresses to other elements within the configuration. This standard does not address how the intelligent system element chooses element addresses for assignment. Element addresses should be assigned so that element address duplication in the same network does not occur.

Regardless of whether an element address is assigned, each element shall always respond to an address of 0xFFFFFFFF when hop count = 0.

The discovery of topologies beyond two ports and the mechanisms for multi-port address assignment are not covered by this standard. Multi-port element support is optional and may be added in a vendor unique manner.

1.7 Admin micropacket flow control

Admin micropacket operations (with the exception of reset) consist of a command and a paired response operation. To avoid overrun of receivers, no more than one operation shall be outstanding to a single destination element from a single source element in a time period of one second.Therefore, elements shall

send only a single command (PING, SET ELEMENT ADDRESS, EXCHANGE ELEMENT FUNCTION, SET LOGICAL ADDRESS, RETURN LOGICAL ADDRESS, READ REGISTER, OR WRITE REGISTER) before receiving the paired response micropacket (PING RESPONSE, ACK SET ELEMENT ADDRESS, ELEMENT FUNCTION RESPONSE, LOGICAL ADDRESS RESPONSE, READ RESPONSE, WRITE RESPONSE) or until a time-out period of one second has elapsed.

Since RESET has no response, elements that have sent a RESET must wait one second before attempting any other operation to the element that has been reset.